AMENDMENTS TO THE CLAIMS

The following listing of Claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) An apparatus for the non-contact electrical test of electronic substrates comprising:

at least one electronic substrate having top surface conductive features on a top side of said electronic substrate in electrical contact with bottom surface conductive features on a bottom side of said electronic substrate;

an ionization source positioned above said top surface of said electronic substrate and connected to a first voltage source;

a fixture holding said electronic substrate;

an array of probes ~~which contact~~ with continual physical contact to said bottom surface conductive features;

a second voltage source electrically connected to said array of probes to maintain said array of probes at virtual ground; and

current measuring electronics in contact with said array of probes.

2. (Original) The apparatus of claim 1 wherein said ionization source is a conductive wire.

3. (Original) The apparatus of claim 1 wherein said ionization source is a mesh of conductive wires.

4. (Original) The apparatus of claim 1 wherein said ionization source is a conductive ribbon.

5. (Original) The apparatus of claim 1 wherein said ionization source is coated with molybdenum disulfide.

6. (Original) The apparatus of claim 1 further comprising a shield between said ionization source and said top surface conductive features.

7. (Original) The apparatus of claim 6 wherein said shield has a cylindrical shape with an opening towards said top surface conductive features.

8. (Original) The apparatus of claim 6 wherein said shield is connected to a third voltage source.

9. (Original) The apparatus of claim 6 wherein said shield is segmented with each segment electrically insulated from each other and separately charged.

10. (Original) The apparatus of claim 8 wherein said first voltage is approximately 5,000 volts, said second voltage is approximately ground and said third voltage is approximately 2,500 volts.

11. (Original) The apparatus of claim 1 wherein said ionization source is a positive ionization source.

12. (Original) The apparatus of claim 1 wherein said ionization source is a negative ionization source.

13. (Original) The apparatus of claim 1 wherein said fixture is comprised of a conductive material.

14. (Original) The apparatus of claim 1 wherein said fixture has a tapered geometry.

15. (Original) The apparatus of claim 1 wherein said fixture is connected to a fourth voltage source.

16. (Original) The apparatus of claim 15 wherein said fourth voltage has a value between said first voltage and said second voltage.

17. (Original) The apparatus of claim 15 wherein said fourth voltage is approximately ground.

18. (Original) The apparatus of claim 1 wherein said current measuring electronics are logarithmic amplifiers.

19. (Original) The apparatus of claim 18 wherein each of said logarithmic amplifiers are connected to said array of probes.

20. (Original) The apparatus of claim 18 further comprising circuitry connected to said array of probes to allow said current measuring electronics to be monitored individually with signals issued through a digital interface from a computer.

21. (Original) The apparatus of claim 20 further comprising an analog-to-digital converter to acquire and store measurements of the analog voltage level from said logarithmic amplifiers.

22. (Original) The apparatus of claim 18 wherein said logarithmic amplifiers are unipolar.

23. (Original) The apparatus of claim 18 wherein said logarithmic amplifiers are bipolar.

24. (Currently Amended) A method for the non-contact electrical opens test of electronic substrates comprising the steps of:

providing at least one electronic substrate having top surface conductive features on a top side of said electronic substrate in electrical contact with bottom surface conductive features on a bottom side of said electronic substrate;

securing said electronic substrate in a fixture;

creating a region of ionized particles at an ionization source positioned above said top surface of said electronic substrate by applying a first voltage to said ionization source;

exposing said top surface conductive features to a cascade of said ionized particles by applying a second voltage to said bottom surface conductive features and thereby creating an electric charge buildup on said top surface conductive features;

draining said charge buildup through said bottom surface conductive features and creating a drain current into an array of probes in <u>continual physical</u> contact with said bottom surface conductive features; and

measuring said drain current with current measuring electronics in contact with said array of probes whereby any opens between a top surface conductive feature and a bottom surface conductive feature is detected by the absence of said drain current.

25. (Original) The method of claim 24 wherein said ionization source is a conductive wire.

26. (Original) The method of claim 24 wherein said ionization source is a mesh of conductive wires.

27. (Original) The method of claim 24 wherein said ionization source is a conductive ribbon.

28. (Original) The method of claim 24 wherein said ionization source is coated with molybdenum disulfide.

29. (Original) The method of claim 24 further comprising the step of focusing said cascade of ionized particles by positioning a shield between said ionization source and said top surface conductive features.

30. (Original) The method of claim 29 wherein said shield has a cylindrical shape with an opening towards said top surface conductive features.

31. (Original) The method of claim 29 further comprising the step of applying a third voltage to said shield.

32. (Original) The method of claim 29 wherein said shield is segmented, with each segment electrically insulated from each other and separately charged.

33. (Original) The method of claim 31 wherein said first voltage is approximately 5,000 volts, said second voltage is approximately ground and said third voltage is approximately 2,500 volts.

34. (Original) The method of claim 24 wherein said ionization source is a positive ionization source.

35. (Original) The method of claim 24 wherein said ionization source is a negative ionization source.

36. (Original) The method of claim 24 further comprising the step of applying a fourth voltage to said fixture.

37. (Original) The method of claim 36 wherein said fourth voltage has a value between said first voltage and said second voltage.

38. (Original) The method of claim 36 wherein said fourth voltage is approximately ground.

39. (Original) The method of claim 24 wherein said current measuring electronics are logarithmic amplifiers.

40. (Original) The method of claim 39 further comprising the step of monitoring said array of probes individually with circuitry connected to said current measuring electronics which measure signals issued through a digital interface from a computer.

41. (Original) The method of claim 40 further comprising the step of storing measurements of the analog voltage level from said logarithmic amplifiers from an analog-to-digital converter.

42. (Original) The method of claim 39 wherein said logarithmic amplifiers are unipolar.

43. (Original) The method of claim 39 wherein said logarithmic amplifiers are bipolar.

44. (Original) A method for the non-contact electrical shorts test of electronic substrates comprising the steps of:

providing at least one electronic substrate having top surface conductive features on a top side of said electronic substrate in electrical contact with bottom surface conductive features on a bottom side of said electronic substrate;

securing said electronic substrate in a fixture;

creating a region of ionized particles at an ionization source positioned above said top surface of said electronic substrate by applying a first voltage to said ionization source;

exposing said top surface conductive features to a cascade of said ionized particles by applying a second voltage to said bottom surface conductive features and thereby creating an electric charge buildup on said top surface conductive features;

draining said charge buildup through said bottom surface conductive features and creating a drain current into an array of probes in <u>continual physical</u> contact with said bottom surface conductive features;

measuring said drain current with current measuring electronics in contact with said array of probes whereby any opens between a top surface conductive feature and a bottom surface conductive feature is detected by the absence of said drain current;

turning off said cascade of ionized particles;

applying a different voltage bias on each individual probe in said array of probes; and

re-measuring said array of probes with said current measuring electronics whereby any shorts are detected by a drain current.

45. (Original) The method of claim 44 further comprising the step of first measuring the voltage bias of each of said array of probes with no ionization source and and no electronic substrate in place to establish reference values for subsequent drain current measurements.

46. (Original) The method of claim 24 further comprising the step of first measuring the voltage bias of each of said array of probes with no ionization source and and no electronic substrate in place to establish reference values for subsequent drain current measurements.